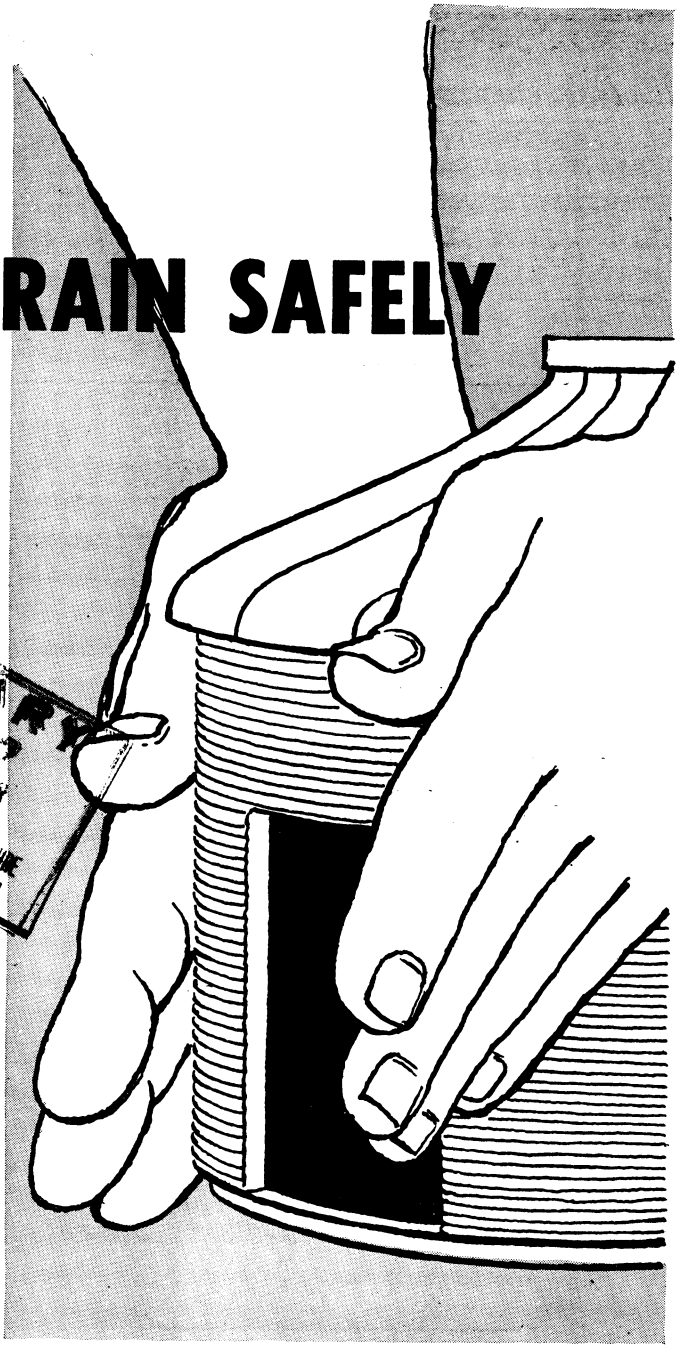
you can

STORE GRAIN SAFELY

on the farm



FARMERS' BULLETIN NO. 2071
UNITED STATES DEPARTMENT
OF AGRICULTURE

Additional Information

Below is a list of publications dealing with the storage of grain on the farm that have been published by the Federal Government. Copies may be obtained by writing the Office of Information, United States Department of Agriculture, Washington 25, D. C. Those publications showing a sales price can only be obtained by writing the Superintendent of Documents, Government Printing Office, Washington 25, D. C., and enclosing a check or money order made payable to the Superintendent of Documents.

Farmers' Bulletin 1260 . . . . . Stored Grain Pests

Leaflet 331 . . . . . Drying Shelled Corn and Small Grain with Heated Air

Leaflet 332 . . . . . Drying Shelled Corn and Small Grain with Unheated Air

Leaflet 345 . . . . . Insects in Farm Stored Wheat

Conservation Bulletin 19 . . . . Ratproofing Buildings and Premises, 10 cents.

Circular 22 . . . . . Rats—Let's Get Rid of Them, 10 cents.

ADDITIONAL INFORMATION ON STORING GRAINS ON THE FARM IS AVAILABLE THROUGH YOUR STATE AGRICULTURAL EXTENSION SERVICE AND YOUR COUNTY AGENT.

Washington, D. C.

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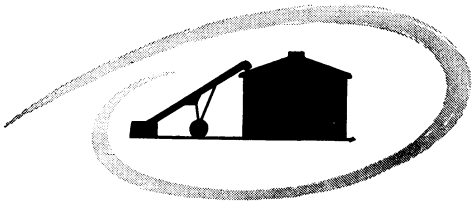


you can STORE GRAIN SAFELY on the farm

Prepared by Agricultural Engineering Research Division,
Agricultural Research Service

Grain can be stored safely on the farm for more than a year if a few precautions are taken.

The moisture content of the grain is especially important; the storage building must be structurally strong and weathertight.

Place only clean grain in unsealed bins. Cracked grain, screenings, chaff, and dust provide favorable conditions for development of insect infestations.

Inspect the storage unit occasionally to detect leaks, insect infestations, and moist, molding, or caking grain.

For information on storing high-moisture corn or grain sorghum, see p. 15.

GRAIN MUST HAVE A LOW MOISTURE CONTENT FOR SAFE STORAGE IN UNSEALED BINS

Safe Moisture Content Varies With Regions

Grain can be stored safely in bins only when it has a moisture content low enough for the region in which it is stored. Excessive moisture will cause souring, heating, or molding, and will promote insect infestation.

Grain must be stored with a lower moisture content in a warm climate than in a colder climate. In the central part of the Corn Belt, for example, grains may be stored without mechanical ventilation for a year or two with no loss of market grade at the following maximum moisture contents:

	Percent
Shelled corn	13
Grain sorghums	13
Oats	13
Wheat	13
Soybeans	12

In colder areas the moisture content may be 1 to 2 percent higher, but in warmer areas the moisture content should be 1 to 2 percent lower, and at least 2 percent lower in the South.

The maximum moisture content specified for a particular region does not mean simply that the grain can average that moisture-content level. Rather, it means that none of the grain in the bin should have a higher moisture content. Higher-moisture-content grain in spots in a bin may result in considerable spoilage.

The maximum moisture content allowable for grain to qualify for Government loans will be specified for the various regions.

Grain Can Be Dried in Storage

Grain can be dried in storage to a safe moisture content using either

unheated or heated air. In either case it is necessary to install a system of ducts (fig. 1) or a perforated floor (fig. 2) to provide a uniform distribution of air through the grain. Grain can also be dried in a drying bin, using heated or unheated air, before being placed in storage.

Drying with unheated air is, under many conditions, satisfactory and relatively inexpensive. The method is dependent upon favorable weather conditions, and is slower than the use of heated air. However, there are no fuel costs, and the cost of equipment is relatively low. In addition to ducts or perforated floor, only a crop-drying fan is needed. Ordinary ventilating fans are not satisfactory.

Grain can be dried rapidly with heated air in any kind of weather. However, there is a fuel cost, and the equipment is more expensive than for unheated air. There are a number of portable crop driers on the market. Each drier consists essentially of a power-driven fan, a heater, and safety controls. These are assembled as a unit and mounted on skids or a rubber-tired trailer. The units usually burn natural or bottled (LP) gas or fuel oil.

Prevent Moisture Build-up in Upper Grain Layers

Even in dry grain there is a tendency, in the colder climates and in the larger bins, for moisture to build up

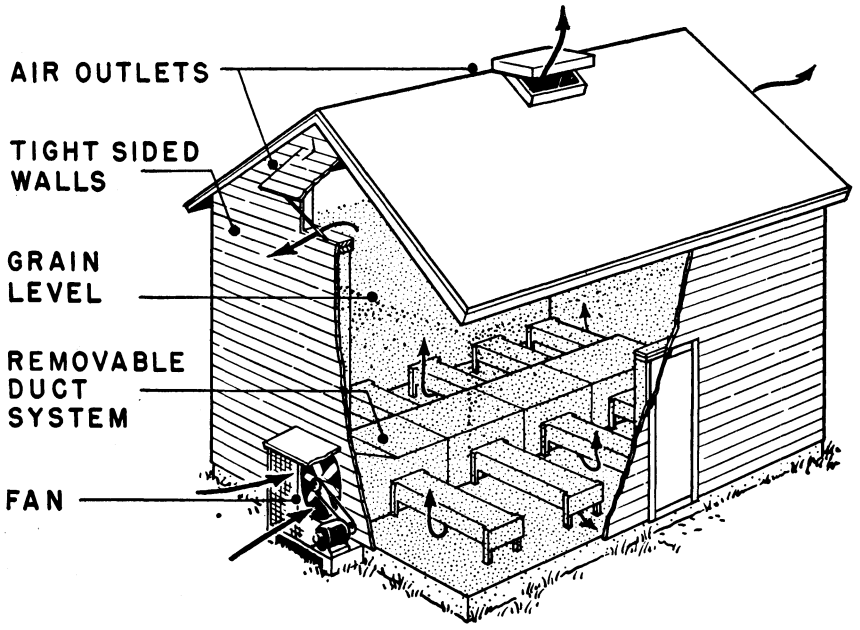


Figure 1.—Rectangular bin with floor duct system for drying with heated or unheated air. The main duct and laterals distribute the drying air to all parts of the bin. A fan for drying with unheated air is shown.

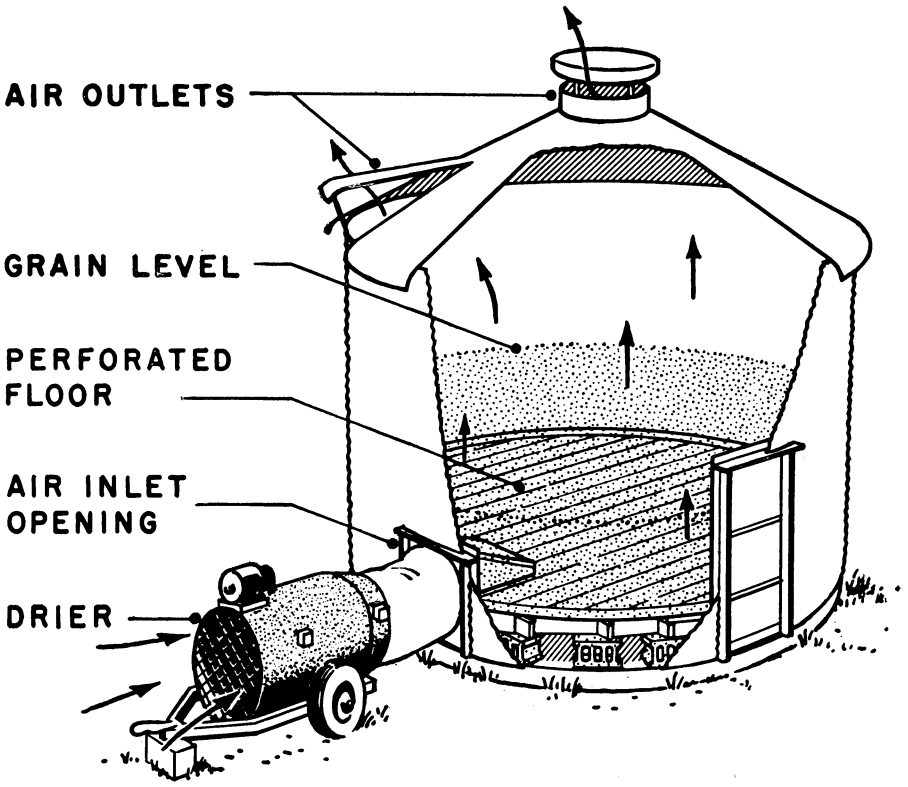


Figure 2.—Metal bin equipped with perforated false floor for drying grain with heated or unheated air. The portable crop drier shown forces heated air through the grain.

in the upper layers of the grain during the fall and winter. This can be prevented with the use of small suction or pressure fans.

The moisture buildup results from the wide differences in temperature of the grain in various parts of the bin. These differences in temperature cause air currents that carry water vapor from the warm bin center to the cooler areas. Generally, the warmer air moves upward, and, when it meets the cooler upper layers of grain, moisture is deposited. Unless this moisture buildup is prevented, the grain will mold and cake.

Spoilage can be prevented by installing perforated pipes or ducts in the bin. Then, during cold weather, a small fan (moving only about a tenth as much air as a drying fan) can draw cool air through the grain to equalize the temperature and prevent moisture from being deposited in the upper layers.

Wind ventilators are available for inducing air circulation through the grain, although they are not as efficient as electric equipment.

REQUIREMENTS FOR A SAFE STORAGE STRUCTURE

It Can Be Built of Many Materials

There is a wide variety of materials that can be used to construct storage structures. These include steel, lumber, plywood, waterproof wallboard, asphaltic roofing and siding, aluminum, concrete, and building tile. Each material, however, must be used with proper regard for its ability to withstand stress and keep out moisture. While moisture is more likely to condense on the underside of a metal roof than on the underside of a wood roof, the possibilities of damage to the grain are no greater. Damage to dry grain from moisture entering the bin is almost always due to leaks, not condensation.

It Should be Properly Located

The grain-storage structure should be located in or near the farmstead, and on a site that is well drained, free from surface water, and is not subject to flooding.

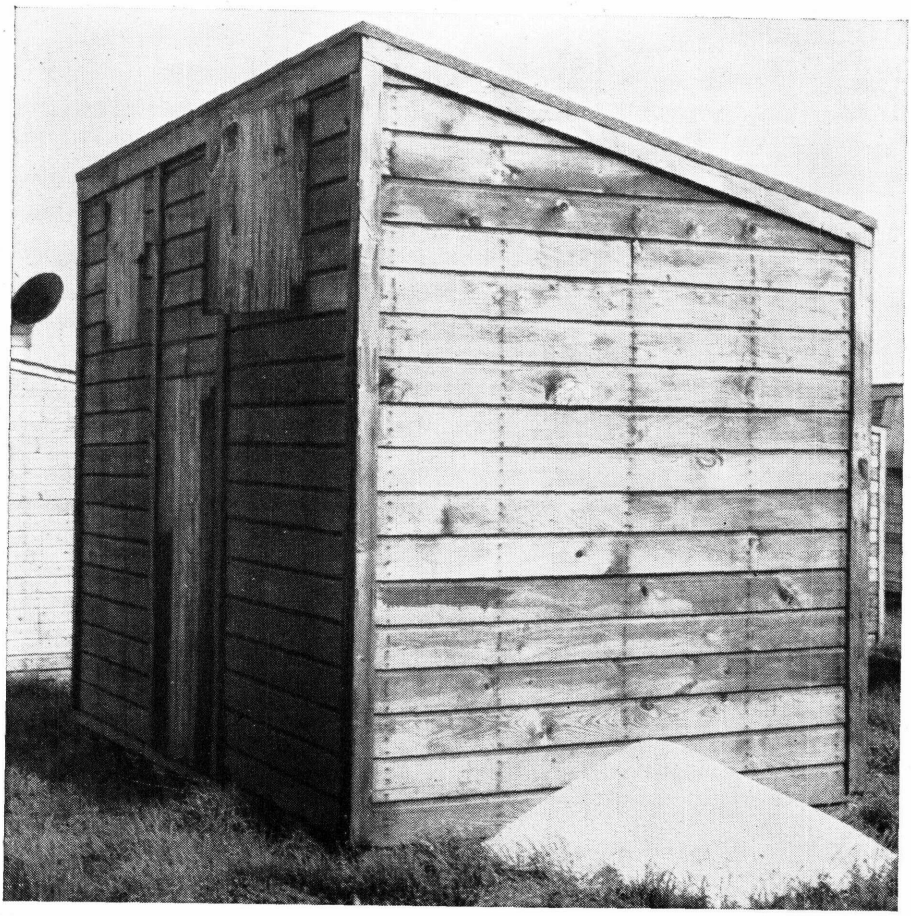


Figure 3.—Grain spilled onto the ground because of failure of a poorly built bin. A bin may fail because of poor nailing, the use of studs that are not sound, or the use of an inferior grade of siding. In this case the nailing was not adequate.

To reduce the fire hazard, the structure should be at least 50 feet (at right angles to prevailing winds) from other buildings and from stacks of hay or straw. Distances up to 100 feet provide better protection from fire, and should be used where possible.

It Should be Structurally Sound

Grain-storage structures must be tighter and stronger than most other farm buildings, in order to withstand the grain pressure against the walls and supports, and the weight on the floor and foundation. Failures from poor construction result in costly repairs and loss of grain (figs. 3 and 4).

To prevent damage from wind, the foundation, floor, walls, and roof must be securely tied together. Bins of light materials particularly need to be anchored since they will stand empty part of the time.

It Should Be Weathertight

All grain-storage structures should be weathertight. Rain or snow entering through walls and the roof can cause heavy damage to stored grain. All door and hatch openings should be weathertight. Special attention should be given to cracks and knotholes in wood construction (fig.

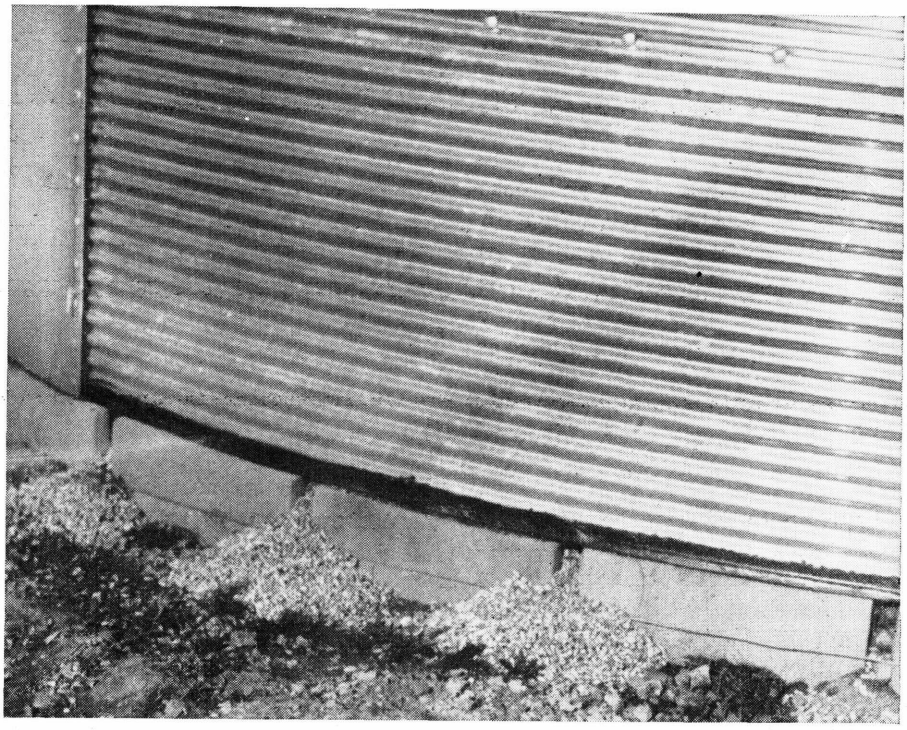


Figure 4.—Grain leaking from a bin because the metal floor was not properly placed. The floor should extend to the wall of the bin, and the fill under the floor should be tamped solidly. The concrete blocks in the foundation should be placed tightly together to prevent the fill from running out from under the floor, and also to prevent rodents from undermining it.

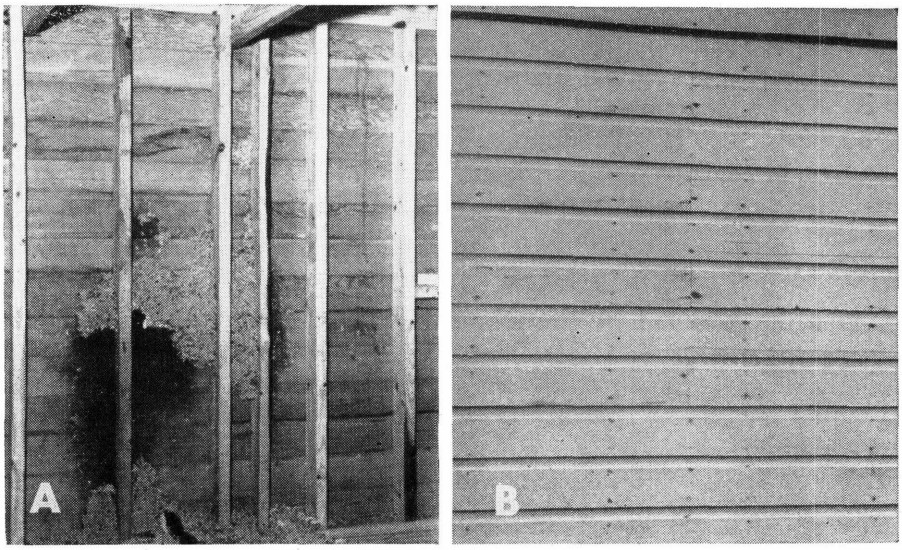


Figure 5.—*A*, Spoiled grain, caking and sticking to the wall, resulted from penetration of rain through the wooden wall. Leakage may result from split boards, knotholes, joints, and other defects. *B*, The outside of the bin wall shown in *A*. The outside of the single wall looks sound, but leakage occurred. It is likely that the water entered through the cracks at the studs where the end joints were made.

5) and to open bolt holes and loose bolts in metal construction (fig. 6). Metal-backed, black neoprene washers should be used under all bolt heads in metal bins. Lead washers may also be used, but are not quite as satisfactory.

It Should Keep Out Ground Moisture

Protection must be provided against the movement of moisture from the ground through the floor of the bin and into the grain. Ground moisture is primarily a problem with concrete floors or other types of floors that are in direct contact with the ground. Floors that are supported above the ground, such as are usually found with frame construction, are relatively free from the hazard of ground moisture.

It Should Be Convenient to Fill and Empty

The right size and type of openings for filling and emptying the storage structure will depend on the type of filling and emptying equipment used. A roof hatch is satisfactory for some types of portable elevators if the building is not too high (fig. 7). However, the opening is uncovered when the elevator is in position. A full-sized entrance door is desirable.

It Should Be Convenient To Inspect, Fumigate, and Clean

The design of the storage structure should permit inspection, sampling, and fumigation of the grain in storage. The grain can be sampled with a deep grain probe if the grain is not more than 16 feet deep and there

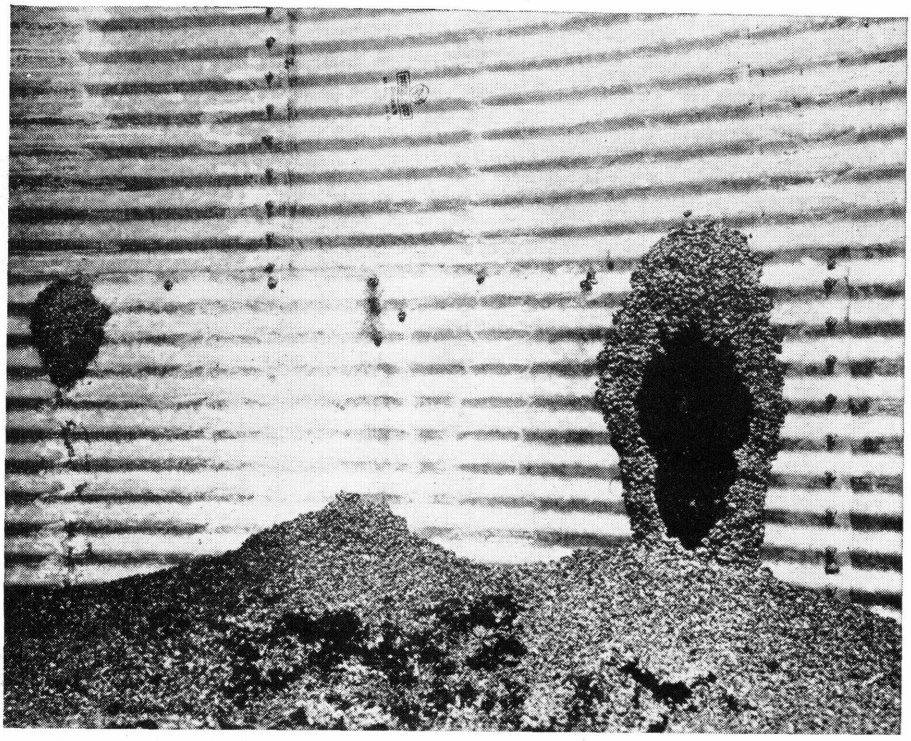


Figure 6.—Inside of a metal bin showing spoiled grain caused by water leakage around the bolts. All bolts should be tight and have metal-backed, black neoprene washers on the outside of the bin.

is 2 to 4 feet of head space above the grain. Cleaning and spraying is relatively easy if the number of places where grain can lodge while emptying is kept to a minimum. Fumigation may be necessary, so provision should be made for temporary sealing of all openings. Tight walls and floors are necessary for effective fumigation.

It Should Keep Out Rodents and Birds

To reduce damage from rats and mice, the storage structure with a wooden floor should have an open foundation. The floor should be 12 to 18 inches above the ground. Birds can be kept out of bins by screening the ventilators and other openings.

BASIC CONSTRUCTION REQUIREMENTS

The Foundations

Permanent foundations should be built of masonry, preferably poured concrete. Semipermanent foundations may be built of concrete blocks, which are used extensively for small and medium-sized bins. The foundations for a frame building should be open at the ends and extend 12 to 18 inches above the ground to protect the wood sills and joists from ground moisture. In areas where

termites may attack, metal termite shields should be placed on top of foundations for frame buildings.

A foundation should have footings large enough to prevent the building from being damaged by uneven settlement. One square foot of bearing surface on the ground for each 50 bushels of grain is satisfactory on most soils. The foundation should rest on firm, undisturbed soil, and should be deep enough to keep from being undermined by erosion, rodents, or livestock.

A steel ring (fig. 8), which is set in the ground, is available for supporting round metal bins. The ring serves both as a foundation and an anchor. This ring is entirely satisfactory, and is preferred to a ring of concrete blocks. If a ring of concrete blocks is used as the foundation for round metal bins, you will need to anchor the bin to prevent the empty bin from being overturned by the wind. You can anchor a bin with "deadmen" buried in the ground, or with posts set next to the bin wall (fig. 9).

Figure 7.—A metal bin being filled with a portable auger elevator. Gasoline-powered elevators can be used where electricity is not available. This bin is equipped with a perforated false floor for drying high-moisture grain.

Heaving by frost action is not a serious hazard to frame or steel bins. These types of structures are flexible

enough to withstand any ordinary amount of distortion caused by heaving.

The Walls

There are three satisfactory methods for constructing the walls of frame storage structures. They are:

(1) On the outside of the studs, place a layer of wood sheathing, then a layer of waterproof paper, and finish with a layer of siding.

(2) On the outside of the studs, place a layer of wood sheathing, and cover with waterproof material, such as sheet metal or asphalt roofing or siding.

(3) On the outside of the studs, place a single layer of exterior plywood, or other waterproof sheets of sufficient strength. Be sure the joints are weathertight.

Figure 8.—Galvanized steel foundation ring for a metal bin is being installed. The ring, which has flanges for anchoring, is partly buried in the ground. It should first be coated with roof-coating asphalt paint. The earth is tamped in place as the trench is filled. The wallsheets are bolted to the upper part of the foundation ring. The bins usually have galvanized steel floors which are placed on an earth or gravel fill after the underside of the floor is painted with asphalt.

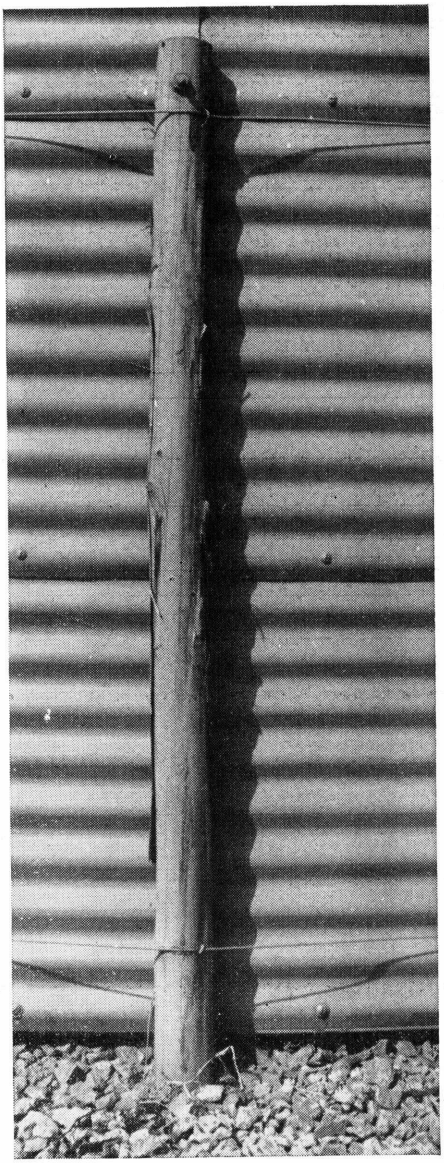


Figure 9.—A post anchor for a metal bin. Four treated posts are set 2½ to 3 feet in the ground and extend 4 feet above the ground. They are bolted to the bin. Two strands of No. 9 galvanized wire are drawn tightly around the bin—one near the top of the post and the other near the bottom.

Do not line the inside of the studs. This reduces the capacity of the bin, provides a favorable situation for development of insect infestations, and makes it difficult to fumigate effectively.

Walls covered with a single layer of drop siding or other matched lumber may be strong enough, but it is hard to make the wall watertight and fumigationtight.

Be sure that studs are strong enough and well nailed to sills or plates. In case of doubt use cross ties (fig. 10).

The Floors

Permanent concrete floors (and foundations) may be used for wood (fig. 11) or for round metal bins. The surface of the floor should be at least 8 inches above the ground. Make certain the bin wall laps below the top of the concrete floor so the bin will be weathertight. If the concrete floor extends beyond the wall of the bin, water will collect on this ledge and work itself into the bin in spite of any precautions that may be taken to make the joint weathertight. A vapor barrier of 6 mil polyethylene film or 55-pound composition roofing should be placed below the concrete floor.

Galvanized sheet-steel floors, laid on earth or gravel fills, are also satisfactory for round metal bins.

Wood floors should be made from tongue-and groove flooring. A tight floor is needed to prevent leakage of grain, and excessive leakage of fumigating gases. An air space of 12 to 18 inches below the floor will permit air circulation and reduce damage from rats.

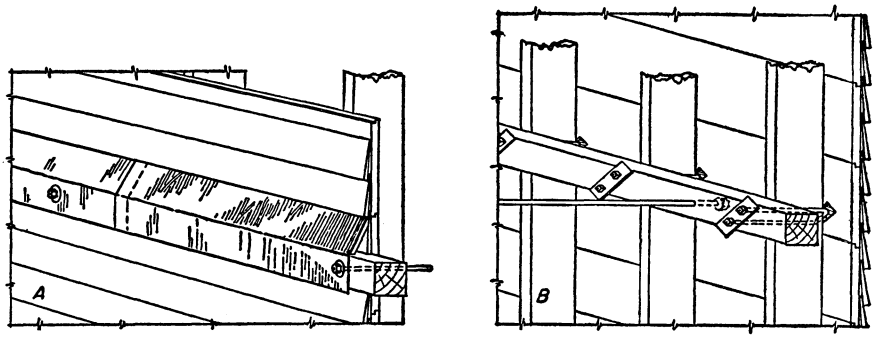


Figure 10.—Methods of reinforcing wall for supporting grain loads. *A*, Exterior stay timber with flashing. *B*, Inside stay timber secured to studs with U-bolts. The tie rods extend through the stay timber. Such tie rods are in the way unless they are above head height, but are an economical means of providing wall strength for bins filled and emptied infrequently.

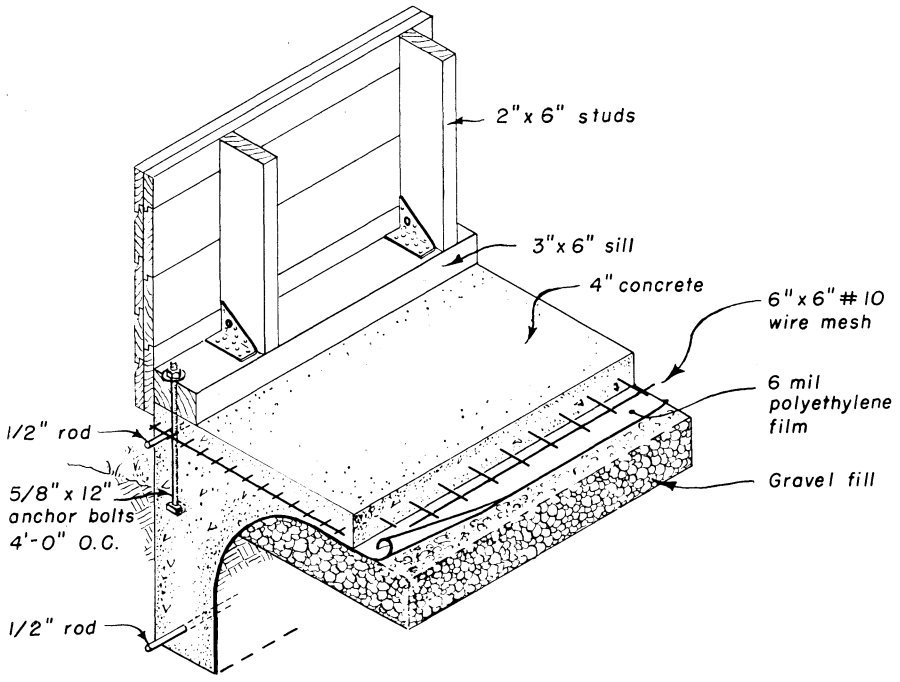


Figure 11.—Concrete floor and foundation for a wood bin. Six mil polyethylene film or composition roofing (55-pound) is used as a moisture barrier. Note the anchor bolts, reinforcing rods, and wire mesh. The wall extends below the level of the floor surface. This floor and foundation can also be used for other types of construction.

YOU CAN BUILD OR BUY NEW STORAGE STRUCTURES

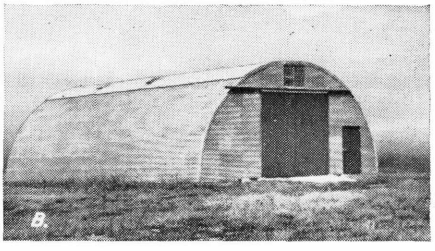
You can build a new storage structure, or you can buy a readymade structure.

Plans for building storage structures have been developed by the United States Department of Agriculture and by State agricultural colleges. These plans are available through your State agricultural extension service and your county agent. There are also plans available from commercial sources. A good plan will show size and spacing for foundation, sills, joists, studs, braces, ties, and rafters, as well as fastenings and other details for proper construction. These should be followed closely.

Readymade storage structures are usually cheaper than those built on the farm unless farm labor and materials can be used. Be sure they meet the requirements for safe grain storage. They should be erected in accordance with the manufacturer's recommendations.

CONVERTING STORAGE STRUCTURES TO OTHER USES

When planning a new storage structure keep in mind the possibility of converting it to other uses when it is no longer needed for storing grain. Some ready-made buildings (fig. 12) and some buildings shown in various plan services (fig. 13) are suitable for other purposes, as well as for drying and storage. When not needed for grain storage, these buildings can be converted to livestock or machinery shelters, feed or fertilizer storage, livestock feeders, brooder houses, or garages.



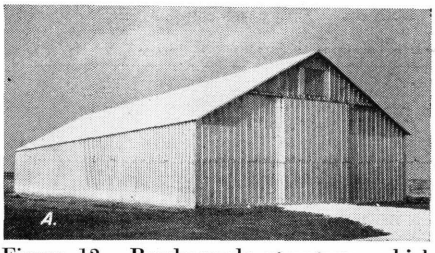


Figure 12.—Ready-made structures which are easily converted to machinery storage, a shop, garage, dairy barn, hay storage or other uses when not needed for grain storage.

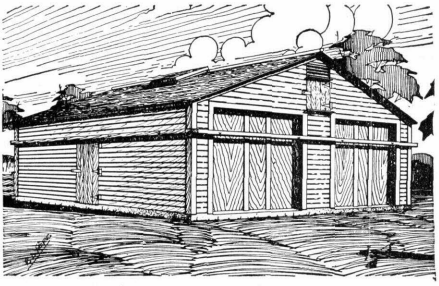


Figure 13.—This 4,500-bushel 2-bin grain storage can be converted easily to a 2-car garage. The 10- by 10-foot openings are left for garage doors with provision for closing them for grain storage. The bins are filled through gable ends or roof hatches. Plans for this storage can be obtained through State agricultural extension services (Midwest Plan 74132).

CONVERTING EXISTING BUILDINGS INTO STORAGE STRUCTURES

Sometimes buildings erected for other purposes may be converted to grain storage. Keep in mind that stronger construction is required in storage structures than in most other farm buildings. If you plan to convert an existing building, be certain it is strong enough to withstand the weight and pressures of the grain.

EQUIPMENT FOR FILLING AND EMPTYING GRAIN BINS

Elevators and conveyors for filling and emptying grain bins are available in two general classes—portable and stationary. There are several types in each class. The particular type to buy, whether it is portable or stationary, will be determined by whether you want it to move only small grain and shelled corn, or if you also want it to handle ear corn.

Portable Elevators

Easily portable elevators are made in auger (fig. 7), belt, flight, and blower types. This equipment greatly reduces the labor required to empty flat-bottomed bins, which are much easier to build than hopper-bottomed bins. The cost of hopper-bottomed bins cannot be justified on farms where the grain is removed from the bin only once or twice a year.

There are two types of blower elevators. In one type the grain is fed into the air stream after it leaves the blower. With this type there is very little grain breakage if the conveyor tubes are smooth and free from sharp turns. In the other type, the grain is fed into the blower. The grain comes in contact with the blower blades and some grain is always broken. This type is not recommended if the grain is to be stored for long periods, because insect infestations and mold growth develop more readily in the presence of broken grain.

Stationary Elevators and Conveyors

Bucket-type stationary elevators and belt- or auger-type conveyors are available for permanent installations. These cause little damage to grain if they are installed and operated according to the manufacturer's instructions.

STORING HIGH-MOISTURE CORN OR GRAIN SORGHUM

High-moisture corn or grain sorghum which is to be fed direct from storage can be stored safely in a sealed structure.

Corn picked early with a picker-sheller or combine, having a moisture content from 25 percent to the upper limit for shelling, and stored in a sealed storage makes good feed for cattle and hogs. Corn or grain sorghum with less than 25 percent moisture and more than safe moisture content for dry storage is apt to mold and deteriorate even in sealed storage.

A storage tank or permanent metal silo with sealed seams and airtight hatches can be used for storing high-moisture corn and grain sorghum. Ordinary silos have also been used for storing grain at 25 percent or greater moisture. In some instances, the silo was lined with plastic sheets and the top surface sealed with plastic and weighted to hold it tight. Silos with walls in good condition have been used successfully by sealing the door openings and the top with plastic sheets. Round bins lined with plastic sheets have been used in the same way.

The following precautions must be observed to store high-moisture grain successfully in ordinary silos:

1. Be sure that the moisture content of the grain lies between recommended limits.
2. Check the storage tank or silo for air leaks.
3. If silo walls show much deterioration or wear, line them with polyethylene or vinyl chloride plastic sheets.
4. Seal the top surface to keep air from contacting the grain.
5. After the silo is opened, the grain must be removed from the surface fast enough to avoid spoilage.

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